

ROTATING, LOCKING INTERVERTEBRAL DISK STABILIZER AND APPLICATOR

CROSS REFERENCE TO RELATED APPLICATION

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The present application is a continuation-in-part of co-pending application Serial
No. 08/475,211, filed June 6, 1995 and entitled ROTATING, LOCKING, MIDDLE-
EXPANDED INTERVERTEBRAL DISK STABILIZER (as amended). Serial No. ^{now issued as Patent No. 5,658,336}
10 08/475,211 was a continuation-in-part of International Application No. PCT/US95/03347
entitled MIDDLE EXPANDED, REMOVABLE, INTERVERTEBRAL DISK
IMPLANT AND METHOD OF LUMBAR INTERVERTEBRAL DISK
STABILIZATION filed on March 17, 1995. International Application No.
PCT/US95/03347 was itself a continuation-in-part of U.S. application Serial No.
15 08/210,229, filed March 18, 1994 and having that same title. ^{now Patent No. 6,093,207}

BACKGROUND OF THE INVENTION

15 The present invention relates to an intervertebral disk stabilizing implant for
stabilizing two adjacent vertebrae. More specifically, the present invention relates to
rectangularly-shaped disk implants which are expanded in the middle portion and are
used for spinal fusion.

20 Treatment of a herniated disk in the neck and in the lumbar region continues to be
a challenging field of medicine. The classical treatment for a ruptured disk is
discectomy, i.e., removal of the disk from between the vertebrae. In this process, all or a
portion of the intervertebral disk is removed, leaving a defect which continues to bother
the patients throughout the rest of their lives. An additional procedure is to replace the
25 disk space with a bone graft, usually bone chips cut from the patient's iliac crest, bringing
about fusion of the vertebrae above and below the disk, eliminating the empty space
between the vertebrae.

30 Discectomy with fusion is not ideal because the replaced bone does not have the
function of the cartilaginous tissue of the disk, i.e. no cushioning effect, and has
complications because of several factors. First, conventional bone plugs used to pack the
disk space do not conform to the space of the disk because the disk bulges maximally in
the center. The disk space is wider in the middle and narrower at its anterior and

posterior ends. For this reason, the various bone plugs which are currently available commercially have only four contact points, i.e. at the front and back of the disk space. Secondly, access to the disk is from the side of the dorsal spine of the adjacent vertebrae, leaving a space that is "off-center" relative to the bodies of the adjacent vertebrae such that the stability of the implant is even more problematical than might be apparent from the limited contact resulting from the shape of the intervertebral space. Another complication is the possibility of infection or other conditions which may require the removal of the implant. Also, if the bone pieces do not fuse, they may eventually extrude out of the disk space, causing pressure on the nerve roots.

Various prosthetic disk plugs, or implants, are disclosed in the art, but all are characterized by limitations of not conforming to the shape of the disk space, lack of stability when inserted off-center, inability to be removed, or other disadvantages. For instance, U.S. Patent No. 4,863,476 (and its European counterpart, EP-A-0260044) describes an elongated body divided longitudinally into two portions having a cam device movable therebetween for increasing the space between the two body portions once inserted into the disk space. However, that device is generally cylindrical in shape such that the only contact points between the device and the vertebral bodies are at the front and back of the disk space, creating increased likelihood of instability and generally rendering that device unsuitable for use after partial discectomy. The art also discloses intervertebral disk prostheses (e.g., U.S. Patent Nos. 3,867,728, 4,309,777, 4,863,477 and 4,932,969 and French Patent Application No. 8816184) which may have more general contact with the adjacent disks, but which are not intended for use in fusion of the disks. The art also includes spinal joint prostheses such as is described in U.S. Patent No. 4,759,769, which is again not indicated for use when fusion is the preferred surgical intervention.

There is, therefore, a need for a device capable of stabilizing the vertebrae adjacent an intervertebral disk, but which is also removable, for use in spinal fusion. There is also a need for a method of implanting such a stabilizer.

SUMMARY OF THE INVENTION

These needs are met in the present invention by providing a vertebral disk stabilizer comprising an elongate implant having first, second, third and fourth sides providing the implant with a substantially rectangular cross-sectional shape of minimal

height defined by the first and second sides and maximal width defined by the third and fourth sides; the third and fourth sides being arched from one end of the implant to the other to provide the portion intermediate the ends with a width larger than the width of the implant at the ends thereof. A lock having a bearing surface formed thereon is detachably mounted to one end of the implant to prevent rotation of the lock relative to the implant with the bearing surface oriented at approximately 90° to the height of the implant.

A key is formed on the lock and a keyway is formed on the implant for receiving the key therein. The opening of the keyway is wider than the width of the key to facilitate insertion of the key therein. The implant is inserted into the disk space with the implant oriented so that the first and second sides thereof engage the bodies of the adjacent vertebrae, rotated approximately 90° in the disk space so that the third and fourth sides contact the bodies of the adjacent vertebrae, and the lock is secured to the implant by inserting the key into the keyway to prevent rotation of the implant relative to the lock. The bearing surface bears against the body of the adjacent vertebrae to prevent rotation of the lock relative to the body of the adjacent vertebrae against which the surface of the lock bears.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a lateral view of a portion of a human spinal column having a preferred embodiment of vertebral disk stabilizer of the present invention inserted therein and having a portion of the bodies of the vertebrae adjacent the implant shown cut away and/or in shadow lines to show the engagement of the vertebral bodies by the vertebral disk stabilizer.

Figure 2 is an exploded, perspective view of the vertebral disk stabilizer of Fig. 1.

Figure 3 is a view of the implant of Fig. 1 and an applicator to which the implant can be mounted in place of the lock shown in Fig. 2, the implant being shown in side, elevational view and the applicator being shown in top, plan view.

Figure 4 is an exploded, perspective view of a second preferred embodiment of the vertebral disk stabilizer of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the figures, a first embodiment of a disk stabilizer constructed in accordance with the teachings of the present invention is shown implanted in a human spinal column in Fig. 1. The vertebral disk stabilizer, indicated generally at reference numeral 10, is implanted between the bodies 12 and 14 of two adjacent vertebrae 16 and 18, respectively, in the disk space (not numbered) from which a portion of the intervertebral disk 20 is removed, i.e. by simple discectomy and small laminotomy.

Referring now also to Fig. 2, the vertebral disk stabilizer 10 is comprised of an elongate implant 22, lock 24, and means for detachably mounting the lock 24 to one end 25 of the implant 22. In the presently preferred embodiment shown, the mounting means takes the form of a bolt 26 passing through a bore 28 in lock 24, the threads of bolt 26 engaging complementary threads in the walls of the bore 30 in the end 25 of implant 22. A lock nut 31 may optionally be provided for resisting the loosening of the bolt 26 once lock 24 is mounted to lock 24 and implant 22 in the manner described below.

In more detail, implant 22 is comprised of first and second sides 32 and third and fourth sides 34 providing a substantially rectangularly shaped cross-section. The height H of the rectangularly shaped cross-section is defined by first and second sides 32 and the width W is defined by the third and fourth sides 34 and, as is apparent by comparison of H and W, the height of H of implant 22 is less than the width W. As will be explained below, H is minimized to facilitate insertion of the second end 36 into, and positioning of implant 22 in, the disk space from which a portion of the intervertebral disk 20 was removed and W is maximized to provide the desired stabilization to adjacent vertebrae 16 and 18. Third and fourth sides 34 are arched from one end of implant 22 to the other to provide the portion of implant 22 intermediate the ends 25 and 36 with a width W which is larger than the width W' and W'' at the ends 25 and 36, respectively. By comparison of the widths at the ends and middle portions of implant 22, it can be seen that in the embodiment shown in Fig. 2, the width W' at the end 25 of implant 22 is less than the width W'' at the end 36 of implant 22. Because the sides 32 of implant 22 are substantially flat and the sides 34 are arched from one end 25 to the other end 36, implant 22 is described as being a bi-planar, bi-convex implant. The bi-convex sides 34 of implant 22 are provided with a plurality of teeth 38 for biting into the adjacent vertebrae 16 and 18 as will be explained in more detail below. The end 36 of implant 22 is formed

in a blunt, or rounded shape to reduce the likelihood of injury to the nerves of the spinal cord during insertion into the disk space.

Those skilled in the art who have the benefit of this disclosure will recognize from the preceding paragraph that the sides 34 of implant 22 need not define an arch which is symmetrical from the end 25 to the end 36 of implant 22. It will also be recognized that the sides 34 of implant 22 need not be provided with the serrations 38 to bite into the adjacent vertebrae. This biting function can also be accomplished by providing the sides 34 with multiple steps formed in right angles from the narrowest portions at the ends 25 and 36 to the widest portion in the approximate middle of implant 22 (i.e., from the dimension W' to W to W").

In the preferred embodiment shown, lock 24 is substantially square when viewed from the end 40 along the axis of the bore 28 therethrough and U-shaped when viewed from the side. The inside surfaces 42 of the arms 44 of the U-shaped lock 24 are flat for contacting the first and second sides 32 of implant 22 to prevent rotation of lock 24 relative to implant 22 when lock 24 is mounted to implant 22 and secured thereto by bolt 26. The sides 32 of implant 22 are provided with a keyway 46 for receiving complementary-shaped keys 48 formed on the surfaces 42 of the arms 44 of lock 24 to facilitate assembly of lock 24 to implant 22; those skilled in the art who have the benefit of this disclosure will recognize that the keyway 46 may be located on the lock 24 and the key 48 may be located on implant 22 without any difference in the manner in which those component parts function. The mouth 45 of the keyway 46 on the side 32 of implant 22 at the first end 25 of the implant is wider than the width of the keyway 46 in the portion of the slot intermediate the ends 25 and 36 of implant 22 to facilitate insertion of the keys 48 of lock 24 into the keyway 46. The funnel-shaped portion 47 of the keyway 46 behind the mouth 45, which gradually decreases in width, acts to increase the ease with which lock 24 is mounted to implant 22 by insertion of the keys 48 into the respective keyways 46 and helps to seat lock 24 thereon and align the bore 28 in lock 24 with the bore 30 in implant 22.

The sides of the square end 40 of lock 24 provide surfaces 50 for bearing against the bodies 12 and 14 of adjacent vertebrae 16 and 18 as also explained in more detail below. It will be recognized by those skilled in the art who have the benefit of this disclosure that the bearing surfaces 50 need not be flat and that the end 40 of lock 24

need not be square. Other shapes and configurations may be utilized as needed to insure that movement of lock 24 is limited by the bodies of the adjacent vertebrae 16 and 18. The purpose of the bi-planar, middle expanded, bi-convex implant 22 is to enable insertion of the implant 22 into the disk space and turning by approximately 90° to increase the disk height and stabilize the disk space. The purpose of lock 24 is to lock implant 22 against instability when in the vertical position so as to maintain the disk height thereafter.

Referring now to Fig. 3, an applicator for use in connection with the present invention is shown at 152 and is provided with an end 154 shaped in the form of a pair of prongs 144. The prongs 144 are formed in a size and shape substantially identical to the size and shape of the arms 44 of lock 24. Applicator 152 is mounted to implant 22 by inserting the prongs 144 into the keyways 46 formed on the sides 32 of implant 22 (note that implant 22 must be rotated by 90° from the position shown in Fig. 3 to be mounted on applicator 152, the implant 22 and applicator 152 being shown in the relationship shown in Fig. 3 to show the structure which enables the implant to be mounted to the applicator). In this manner, the prongs effectively function in the manner of the keys 48 formed on the surfaces 42 of the arms 44 of lock 24, seating the implant 22 on the end of applicator 152 and preventing relative rotational movement between implant 22 and applicator 152. Although not shown in the figure, those skilled in the art who have the benefit of this disclosure will recognize that the end of the keyways 46 may be extended along the sides 32 of implant 22 further than is necessary to receive the keys 48 on lock 24 and that the extra length of the keyways 46 may be of gradually reducing dimension so that the prongs 144 of applicator 152 are received in a friction fit in the keyways 46 to help affirmatively mount implant 22 thereto. Other structure for achieving this same result includes a detent or serrations formed in the keyways 46.

When the end 154 of applicator 152 is seated all the way into the keyways 46 of implant 22, so as to prevent relative rotational movement therebetween, implant 22 is inserted into the disk space and rotated therein using applicator 152 as explained below. Applicator 152 is then detached from implant 22 simply by withdrawing the applicator 152 from the disk space, the friction exerted by the adjacent vertebrae preventing the withdrawal of the implant 22. It will be apparent to those skilled in the art who have the benefit of this disclosure that the applicator 152 is of little assistance in removing the

implant 22 from the disk space even if the keyways 46 of implant 22 are provided with a detent or other structure to engage the prongs 144 of applicator 152 to retain the implant 22 thereon. In the event the implant 22 needs to be removed from the disk space, an applicator of the type shown in my prior, ^{U.S. Patent No. 5,668,336} ~~co-pending application Serial No. 08/475,211~~,
5 which disclosure is incorporated in its entirety as if fully set forth herein by this specific reference thereto, is screwed into the bore 30 to allow the implant 22 to be pulled from the disk space.

A second embodiment of the implant of the present invention is shown in Fig. 4. In this second embodiment, the structure corresponding to the structure of the
10 embodiment shown in Figs. 1-3 is designated with a prime to distinguish between the two embodiments. The arms 44' of lock 24' are shaped so that the arms 44' themselves provide the keys 48' which fit into the complementary-shaped keyways 46' on the surfaces 32' of implant 22'. Specifically, the arms 44' forming the U-shaped lock 24' are
15 shaped in the form of prongs which fit into the keyways 46' of implant 22 in much the same manner as described for the prongs 144 of the applicator 152 shown in Fig. 3. In this manner, the lock 24' functions in the same manner as the lock 24 of Figs. 1-3 to prevent rotation of implant 22' once inserted into the disk space and rotated by approximately 90°.

The use of the stabilizer 10 of the present invention in, for instance, a method of
20 lumbar intervertebral disk stabilization is illustrated in Fig. 1. Surgery is performed as in a simple discectomy and the intervertebral disk 20 is exposed through a small laminotomy. The disk material is removed and any nerve root compression is corrected. The posterior longitudinal ligament (not shown) and disk cartilage are removed until the surface of the bodies 12 and 14 of adjacent vertebrae 16 and 18, respectively, are
25 exposed above and below the disk space.

Using spreaders such as those disclosed in my International Application No. PCT/US95/00347, which reference is hereby incorporated into this specification in its entirety by this specific reference thereto, the vertebrae 16 and 18 are distracted to open the disk space, and once the desired "spread" is achieved, the middle portion of the disk
30 space is packed with cancellous bone chips (not shown). Because the posterior longitudinal ligament is left intact to the opposite side and to the center of the disk space, the bone chips are held in place in the disk space.

close off the remaining portion of the opening into the disk space. The patient should be able to ambulate soon after the procedure because of the stability imparted to the spinal column by the implant of the present invention. Before narrowing of the disk space occurs, the cancellous bone chips will have started the fusion process.

5 The stabilizer 10 is also used to advantage to perform, for instance, a posterior lateral intertransverse fusion. The implant 22 is inserted into the region of the disk space from which a portion of the disk has been removed as described above with the lock 24 and the posterior lateral fusion performed. Because the implant 22 provides stability to the spine until the posterior lateral fusion is solid, the patient is generally able to
10 ambulate soon after surgery. This procedure also prevents the narrowing of the disk space, which is a common problem with posterior lateral fusion.

Removal of the implant 22 is accomplished with relative ease compared to conventional implants. The bolt 26 is screwed back out of implant 22 and lock 24 is pulled out of the disk space. An applicator of the type described in the above-
15 incorporated Serial No. 08/475,211 is inserted into the disk space and screwed into the bore 30 in implant 22 and used to rotate implant 22 by approximately an additional 90°, causing the first and second sides, having minimal height, to contact the bodies 12 and 14 of adjacent vertebrae 16 and 18 so as to allow posteriorly-directed movement of the implant 22 out of the disk space.

20 Although described in terms of the preferred embodiment shown in the figures, this embodiment is shown to exemplify the present invention, it being recognized by those skilled in the art that certain changes can be made to the specific structure of the preferred embodiment shown and described without departing from the spirit of the present invention. In the case of one such change, the first and second sides of the
25 implant are substantially flat but not parallel along their longitudinal axes so that the implant is wedge-shaped. The wedge shape of the implant facilitates insertion of the implant into the disk space, the rounded end of the implant reducing the likelihood of injury to the nerves of the spinal cord during insertion into the disk space. Likewise, the width at one end of the implant can be less than the width at the end, both widths,
30 however, being less than the width in the middle, expanded portion of the implant. Further, the connection by which lock 24 is mounted to implant 22 is capable of being constructed in a manner different than that shown in the figures herein. Another such

implant into the disk space, the rounded end of the implant reducing the likelihood of injury to the nerves of the spinal cord during insertion into the disk space. Likewise, the width at one end of the implant can be less than the width at the end, both widths, however, being less than the width in the middle, expanded portion of the implant.

- 5 Further, the connection by which lock 24 is mounted to implant 22 is capable of being constructed in a manner different than that shown in the figures herein. Another such modification relates to the teeth 38 formed on the sides 34 of implant 22. So as to provide additional resistance to forward or backward movement of implant 22 in the disk space, the teeth 38 located closest to the end 25 of implant 22 (e.g., the teeth in the distal
- 10 portion of implant 22) may be oriented at a slant toward the end 25 and the teeth 38 closest to the end 36 of implant 22 may be oriented at a slant toward the end 36. The teeth in the middle portion of implant 22, e.g., between the two sets of slanted teeth, are then oriented vertically. All such modifications, and other modifications which do not depart from the spirit of the present invention, are intended to fall within the scope of the
- 15 following claims.